Beauty and the Beast
Beauty and the Beast: The Coevolution of Plants and Animals by Susan Grant
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for alternative energy sources are gone. The fact that biological sources for industrial chemicals and fuels can help alleviate other problems, such as the production of acid rain and toxic by-products, seems to be ignored. As long as short-term economics dominate decision making, these topics are not likely to move into the mainstream of our national scientific effort.

This book covers important areas of science and technology, and the authors and editor should be commended for their efforts. We all stand to suffer the consequences of the national and international policies that will probably make this book less than a best-seller among scientists and engineers.

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FOOD AND ENERGY: WILL THERE BE ENOUGH?

Food and Energy Resources. David Pimentel and Carl W. Hall, Academic Press, Orlando, FL, 1984. 268 pp., illus. $46.00 (cloth).

Researchers are now examining the sustainability of world food production systems from many perspectives. The close link between future supplies of energy resources and our ability to feed ourselves is an important component of this concept. Published as part of a series on food science and technology, a collection of works normally aimed at very specific disciplines within the food industry, this volume brings together contributors from several disciplines in an attempt to provide a broader perspective on how energy, land, and water resources influence food production. The book's objective stated in the preface is "to give the reader a clearer understanding of the food and energy resource issues and to serve as a background for making difficult public policy decisions for the future."

The book's ten chapters cover many aspects of food and energy issues. Pimentel's opening chapter thoroughly summarizes his more than ten years of research on energy flow in food systems. He applies his well-known input/output analysis model, presented within an ecological framework, to a range of simple to complex food systems and activities ranging from growing food to processing and transporting it. The next two chapters by Hall provide more basic biological knowledge about energy conversion efficiencies and how energy is used for the complex set of operations involved in agriculture. The key to sustainability, he states, "is to maintain production of food while decreasing dependence on external or commercial energy." Chapter 4, "Food for People," presents statistics on food production levels and population growth rates. Clearly, we need to increase food production while decreasing population growth, but solutions to this problem lie as yet in the future, if indeed we can find them soon enough.

Chapter 5, which offers a specific case study of energy use in crop systems in northeastern China, is very important in light of the current drive to modernize Chinese agriculture. Traditionally considered very energy efficient, it will be interesting to see what, if any, compromises are made if the modernization process accelerates.

The next chapter, "Farm Family Ecosystem," offers a social science perspective on energy and food relationships in developing countries. This approach attempts to integrate a farm system's ecological and cultural components, focusing on methodology rather than actual case-study analysis. Chapter 7 is an intriguing foray into ethical issues of energy and food conversion systems, with a challenging look at the vagaries and variations in the ways we gather and use information. Chapter 8 is a very up-to-date review of solar technologies and energy management systems applicable to agriculture; it emphasizes how solar energy can be more extensively used in food production.

The last two chapters explore both sides of the conflict over using biomass, crop residues, or grain for fuel production. These chapters review in detail the technological systems for alcohol production, but fortunately, they also thoroughly cover the dangers of looking only at fuel needs and not fully assessing potential impacts on food availability in a world of diminishing resources. Clearly, our first priority is to produce food.

The book in general is well produced and accurate, consolidating much information that has been widely scattered in the literature. The authors "hope that this book will provide engineers, economists, agriculturalists, geographers, ecologists, nutritionists, sociologists, and natural resource specialists a perspective that will allow us to work jointly on the problem of providing food for people while protecting our natural resources." Energy accounting, as this book proposes, can go a long way towards solving some of these problems. Problems arise, though, if such accounting is done by those who "shade or distort truth in seeking budgetary and institutional advantage" (p. 178). It will take a coordinated and interdisciplinary effort to ensure that sustainable, long-term changes take place. I would hope that such a focus will allow us to find solutions before the point where, "as with all forms of life, ultimately nature will control human numbers" (p. 87).

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BEAUTY AND THE BEAST

Beauty and the Beast: The Coevolution of Plants and Animals. Susan Grant. Charles Scribner's Sons, New York, 1984. 215 pp. $14.95 (cloth).

Studies of coevolution have increased almost exponentially during the past 20 years. In this popular account of how animals and plants coevolved, Grant attempts to integrate a variety of these studies, drawing on a broad array of papers published mostly between the mid-1970s and 1981. Some of the examples she uses describe specific coevolution between particular animals and plants; others illustrate coevolution more generally. Grant accurately reviews most of the papers she highlights

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here, although in some cases she overstates the generality of claims made. For example, it is not true that nearly all the wild umbellifers contain furanocoumarins (p. 61).

The book does not try to grapple with the theoretical questions and suggested patterns in coevolution that are increasingly prominent in research literature. Instead, Grant tries to spark interest in the natural history of coevolution by convincing general readers that plants and animals interact in much more sophisticated and intricate ways than nonspecialists could imagine from a walk in a field or forest. She does not cite papers in the text; instead, a section of further readings at the end of the book lists the papers on which each chapter was based.

The book is divided almost equally between antagonistic and mutualistic interactions. The part on antagonistic interactions explains coevolution in terms of an arms race scenario, with each side continually deploying new defenses and counterdefenses. (Her analogies include "Barbed wire and bodyguards," "Fleeing from the wrath to come," "Repellents, poisons, and contraceptives," and "One man's meat is another man's poison.") The book switches abruptly from antagonism to mutualism. The link between both kinds of interactions is not really made clear until the last few pages, and then only for some symbiotic mutualisms between microorganisms and larger eukaryotes. Nonetheless, many mutualisms seem to have evolved from initially antagonistic interactions, and the antagonistic components are still visible. In fact, one of the major current problems in coevolutionary theory is understanding the ecological conditions that particularly favor the evolution of mutualistic interactions from antagonistic interactions.

Unfortunately for a book of this sort, it contains no illustrations except for the delightful sketches that face the first page of each chapter. It would have been nice to have had some additional pictures or line drawings that would give nonbiologists a look at some of the species and interactions discussed, for example, an *Acacia* with its mutualistic ants, or the pollen-coated hind legs of a honeybee.

Overall, this pleasant book is much better than many others on natural history, for it sometimes associates results with researchers. So many similar books present biological knowledge as an amorphous collection of universally known facts or interpretations. Grant makes it clear that biologists ask the questions and that the answers are generating more questions.

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SOCIOECONOMICS OF BIOTECHNOLOGY

The Gene Business: Who Should Control Biotechnology? Edward Yoxen. Harper & Row, New York, 1984. 230 pp. $15.95 (cloth).

Many of my boyhood hours were spent happily dreaming of the fabulous future predicted in the pages of popular science and technology magazines, which had sprung up earlier to brighten the Great Depression. A few predictions of the genre have actually appeared, such as helicopters, rocketships, and wrist-radios. Most of the wonders, though, have yet to materialize, such as three-dimensional television; inexpensive power generated by the temperature differential between the stratosphere and the earth's surface; and fantastic underground cities free from disease or climatic extremes, safe from bomb attacks. Today it seems a blessing that the plans to turn the Great Wall of China into a motor highway never came to fruition (*Wasn't the Future Wonderful?* by Tim Onosko, E. P. Dutton, 1979).

I traded an innocent child's delight in daydreaming about technological utopias for the exciting awareness that events in the real world are controlled by complex, abstract forces that have a logic of their own. Schemes that look very sound on the drawing board may not be possible in real life. The direct and indirect costs of a scheme, the public psychology, or even safety considerations were often invisible to inventors and engineers, used to working from handbooks of solid numbers and formulas. My dreams of technological utopias gradually rusted away and were replaced by an appreciation for the complex and powerful forces of socioeconomics that rule so much of life.

It is the socioeconomic dimension of biotechnology that *The Gene Business* focuses on. This is not, as the subtitle might seem to suggest, the definitive book that we await on the question of safety and regulation. It does not, for example, dwell on the question that occupies university administrators of how the profits should be divided. It is the public, after all, that for decades has been bankrolling the enormous basic research effort that has made the technology possible. The book does not discuss the renewed arms race in biological warfare. Yoxen treats these as side issues.

Instead, this is the first book I have found that attempts to explore deeply and realistically the socioeconomic implications of gene-splicing and biotechnology in general. Can we squeeze out of this new power anything close to the technological utopia that its promoters picture for us? Might the dream backfire and even increase social and economic problems in the long run? Yoxen argues that the new power does indeed have terrific potential for good, but it will not be realized unless we begin to think of biotechnology in more realistic terms.

"A basic aim of my argument is that we should react critically to the rhetoric that already surrounds biotechnology. Everywhere you look you find hyperbole and grotesque simplification," he writes. One may agree or not with his skepticism on any given issue, but the pages are leaven for thought, and moments among them are stimulating and pleasant respites from the usual two-dimensional, flat-bread level of public discussion. He is critical in the best sense.

The book is well focused and yet it is an excellent general introduction to this subject. Yoxen makes important, if arcane, matters of both socioeconomics and molecular biology understandable and interesting for general readers. He packs the book with behind-the-scenes information on dealings and projects of the biotechnology

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